

WHAT IS CLAIMED IS:

1. An interconnection contact structure assembly comprising an electronic component having a surface, a conductive contact terminal carried by the electronic component and accessible through the surface, an internal flexible elongate member having first and second ends and with paid first end forming a first intimate bond to the surface of said conductive contact terminal without the use of a separate bonding material and an electrically conductive shell formed of at least one layer of a conductive material with said at least one layer enveloping the elongate member and forming a second intimate bond with at least a portion of the conductive contact terminal immediately adjacent the first intimate bond.

2. A structure as in Claim 1 wherein the strengths of the first and second intimate bonds as measured by pull, shear and/or bend can be characterized as being greater for the second intimate bond than the first intimate bond.

3. A structure as in Claim 2 wherein the strength of the second intimate bond is at least twice that of the first intimate bond.

4. A structure as in Claim 1 wherein said at least one layer is compressively stressed.

5. A structure as in Claim 1 wherein said internal flexible elongate member and said at least one layer of the shell are formed to provide a cantilever to impart a resilient characteristic to the interconnection contact structure.

6. A structure as in Claim 1 wherein said shell has an outer layer and wherein said outer layer is a solder alloy.

7. A contact structure for use as an interconnect with an assembly which incorporates a semiconductor device, the assembly including an electronic component which includes a surface having at least one conductive contact pad thereon, said contact pad having a surface, said contact structure comprising at least one conductive flexible elongate element having first and second ends, means bonding the first end to the surface of the contact pad to form a first intimate bond, a shell substantially enveloping the flexible elongate element and at least a portion

of the surface of the conductive contact pad immediately adjacent the means bonding the first end of the flexible elongate element to the contact pad to provide a second intimate bond so that the strength of the second intimate bond is greater than that of the first intimate bond.

8. A structure as in Claim 7 wherein said shell is formed of at least one layer of a conductive material.

9. A structure as in Claim 8 wherein said flexible elongate element is provided with at least one cantilever forming a bend.

10. A structure as in Claim 9 wherein said conductive shell has a high-yield strength.

11. A structure as in Claim 10 wherein said conductive material of said shell is principally formed of a material selected from the group of nickel, cobalt, iron, phosphorous, boron, copper, tungsten, molybdenum, rhodium, chromium, ruthenium, silver, palladium and their alloys.

12. A structure as in Claim 8 wherein said shell includes a layer which provides internal compressive stresses.

13. A structure as in Claim 7 wherein said second <sup>e</sup> end is a free end.

14. A structure as in Claim 13 wherein said free end has a ball-like configuration.

15. A structure as in Claim 7 together with an outer conductive layer adherent to the shell of a conductive material, said outer conductive layer being formed of a material to which good electrical connections can be made.

16. A structure as in Claim 7 wherein said shell has an exterior surface, said exterior surface having micro protrusions formed therein.

17. A structure as in Claim 9 together with a conductive flexible material mass extending from said surface of the contact pads and over the bend to minimize the inductive characteristics of the bend while permitting flexure of the bend.

18. A structure as in Claim 13 wherein said free end extends above the surface of the electronic component.

19. A structure as in Claim 13 wherein said free end extends down below the surface of the electronic component.

20. A structure as in Claim 7 together with a layer of dielectric material disposed on the shell and an additional layer of conductive material disposed on the dielectric material to provide a shielded contact structure.

21. A structure as in Claim 10 wherein said second end is free so that the second end can serve as a resilient probe contact to resiliently engage the contact terminal.

22. A contact structure as in Claim 21 wherein said contact structure includes a depending portion serving as an electrical contact.

23. A contact structure as in Claim 13 wherein said free end is provided with a contact pad carried by the free end and having at least one layer with a plurality of spaced apart protrusions.

24. A structure as in Claim 23 wherein said layer having protrusions is formed of a hard conductive material.

25. A structure as in Claim 24 wherein said hard conductive material is selected from the group nickel, cobalt, rhodium, iron, chromium, tungsten, molybdenum, carbon and their alloys.

26. A structure as in Claim 10 wherein said probe and is provided with a cantilevered portion adjacent the free end.

27. A structure as in Claim 7 together with means bonding the second end to the same conductive contact pad to which the first end is bonded and solder enveloping said contact structure and serving to form a solder bump.

28. A structure as in Claim 27 wherein said shell has an exterior layer which is formed principally of a solder material.

29. A structure as in Claim 7 wherein said flexible elongate element is formed into loops extending over the contact pad and enclosing a planar surface area therebetween with the shell being formed on the flexible elongate element and solder means secured to the shell of the flexible elongate element and forming a solder bump covering the enclosed planar area.

30. An interposer for use in a semiconductor assembly, a substrate formed of an insulating material having first and

second spaced apart surfaces and having a plurality of spaced apart contact pads on at least one of said surfaces and a plurality of contact structures mounted on the contact pads on said at least one of the surfaces, each of said contact structures including at least one flexible elongate element having first and second ends, means bonding the first ends to a contact pad and having a shell of conductive material formed on the flexible elongate elements and bonded to the contact pad, the second end being free and extending above the substrate.

31. An interposer as in Claim 30 wherein said substrate is provided with holes extending through the substrate together with additional flexible elongate elements secured to the contact pads and extending through the holes and a shell formed of a conductive material on the additional flexible elongate elements.

32. An interposer as in Claim 31 wherein said flexible elongate element is formed with a bend therein having a cantilever portion and wherein said shell is formed of a material having a high yield strength of at least thirty thousand pounds per square inch.

33. An interposer as in Claim 31 wherein said holes have portions which are offset with respect to each other extending through the first and second surfaces and providing shoulders which are recessed with respect to the first and second surfaces together with contact pads disposed on said shoulders and wherein said contact structures are secured to the contact pads disposed on the shoulders and have free ends which extend outwardly through the holes beyond the first and second surfaces to provide free ends which lie in the spaced parallel planes.

34. An interposer as in Claim 31 wherein said holes having conductors extending therethrough.

35. An interposer as in Claim 31 wherein said holes are in the form of plated-through holes and wherein said contact structures are disposed on contact pads on one of the first and second surfaces together with additional contact structures extending across the plated-through holes and being bonded to contact pads on the other side of the substrate, said additional

contact structures including flexible elongate elements and a shell formed on the flexible elongate elements.

36. An interposer as in Claim 35 wherein said additional contact structures are substantially loop-shaped in elevation together with solder formed on the additional contact structure to provide a solder bump.

37. A semiconductor device assembly comprising an active semiconductor device having surface with contact pads formed thereon and a plurality of contact structures mounted on the contact pads, each of said contact structures including a flexible elongate element having first and second ends, means bonding the first end to the contact pad with the second end being free and a shell formed on the flexible elongate element and formed of a conductive material which extends over the flexible elongate element and at least a portion of the contact pad to which it is secured, said flexible elongate element having a cantilever portion forming a bend therein, said contact pads being spaced apart at predetermined distances, the free second ends of said contact structures being spaced apart at greater distances than the spacing between the first ends of the flexible elongate elements bonded to the contact structures.

38. An assembly as in Claim 37 wherein the second free ends are staggered with respect to the first ends of the flexible elongate elements.

39. A semiconductor assembly as in Claim 37 together with registration pins secured to and mounted on the surface of the semiconductor device, said registration pins being formed of a flexible elongate element and a shell formed on the flexible elongate element.

40. An assembly as in Claim 39 wherein said flexible elongate element and said shell of the registration pins being formed of the same materials as the contact structures.

41. A semiconductor package assembly comprising a substrate formed of an insulating material having first and second surfaces and having contact pads disposed on at least one of the first and second surfaces, at least one active semiconductor device having a first surface and having contact pads and interconnecting

resilient contact structures having first and second ends and having the first ends adapted to be bonded to either the pads carried by one surface of the substrate or to the contact pads of the semiconductor device to form bonds therewith and having the second ends adapted to make contact with the contact pads of the semiconductor device or the contact pads carried by one surface of the substrate free of bonds, said interconnecting contact structures each being comprised of a flexible elongate element having a cantilevered portion forming a bend therein and a shell of a conductive material having a high yield strength of at least thirty thousand pounds per square inch disposed on the flexible elongate element and serving to provide spring characteristics to the interconnecting contact structures to resiliently secure the active silicon device to the substrate.

42. An assembly as in Claim 41 together with at least one additional active semiconductor device having contact pads and means connecting the contact pads with the at least one additional active semiconductor device to the contact pads in the other surface of the substrate.

43. An assembly as in Claim 42 wherein said means connecting the contact pads of the at least one additional semiconductor device to the contact pads on the other surface of the substrate includes interconnecting contact structures of the same construction as the first named interconnecting contact structures.

44. An assembly as in Claim 41 wherein the shells formed of a conducting material are intimately bonded to the contact pads so as to provide additional pull strength securing the contact structures to the contact pads.

45. An assembly as in Claim 41 wherein said substrate is a printed circuit board and wherein said printed circuit board is provided with a plurality of layers of metallization and vertical via conductors extending therethrough and wherein the contact pads are in contact with the vertical via conductors.

46. An assembly as in Claim 41 together with spring clip means secured to the substrate and extending over the semiconductor device to retain the at least one active

semiconductor device in a predetermined position with respect to the substrate and placing compressive forces on the interconnecting resilient contact structures.

47. An assembly as in Claim 46 wherein said spring clip means is formed of the same materials as the interconnecting resilient contact structures.

48. An assembly as in Claim 45 wherein the interconnecting contact structures have second free ends and wherein the second free ends extend through the vertical via conductors in the printed circuit board and frictionally engage the vertical via conductors to form electrical contact therewith while serving to retain the semiconductor device in a predetermined position with respect to the substrate.

49. An assembly as in Claim 41 wherein said substrate is provided with a plurality of holes and spring clip means secured to the semiconductor device and extending through the holes and engaging the printed circuit board for retaining the semiconductor device in a predetermined position with respect to the substrate and to place compressive forces upon the resilient contact structures connecting the contact pads on the substrate to contact pads on the semiconductor device.

50. An assembly as in Claim 41 wherein said substrate is provided with a plurality of alignment holes, alignment pins mounted on said semiconductor device and extending through said holes in said substrate for maintaining alignment of the semiconductor device with respect to the substrate and adhesive means disposed between the semiconductor device and the substrate for retaining the semiconductor device in the predetermined position with respect to the substrate in the alignment determined by the alignment pins.

51. An assembly as in Claim 50 wherein said alignment pins are formed of elongate elements having shells formed thereon to provide additional structural support for the flexible elongate elements.

52. An assembly as in Claim 41 together with a capacitor disposed between said first semiconductor device and said substrate, said capacitor having contact terminals and means

coupling said contact terminals to the contact pads of the first semiconductor device.

53. An assembly as in Claim 52 wherein said substrate is formed with a recess therein and wherein the capacitor is disposed therein.

54. An assembly as in Claim 52 wherein said means coupling the contact terminals to the contact pads with the first active semiconductor device includes contact pads disposed adjacent the recess.

55. An assembly as in Claim 41 wherein said substrate is provided with a second surface having steps therein at different levels and wherein contact pads are provided on the steps and wherein contact structures are secured to the pads on the steps and have free ends extending into the same horizontal plane.

56. An assembly as in Claim 41 wherein said substrate is provided with a recess extending through the first surface, a capacitor disposed in the recess and additional contact structures carried by the capacitor and terminating in the same plane as the contact pads with the semiconductor structure and secured to the semiconductor device and making electrical contact to the semiconductor structure.

57. An assembly as in Claim 41 together with an integration substrate having a plurality of contact pads thereon together with additional resilient contact structures interconnecting the contact pads of the substrate to the contact pads of the integration substrate.

58. An assembly as in Claim 57 together with a plurality of additional substrates mounted on the integration substrate and contact structures connecting the additional substrates to the integration substrate.

59. An assembly as in Claim 58 wherein said contact structures interconnecting said substrates to said integration substrate include an interposer having a first and second sides and having contact pads thereon with electrical interconnections between at least certain of contact pads on the first and second sides, said contact structures making contact with the contact pads on the interposer and contact pads on the substrate and



solder means forming a connection between the contact pads of the interposer and the contact pads of the integration substrate.

60. An assembly as in Claim 59 wherein said resilient contact structures yieldably engage the contact pads of the interposer, the substrate or the integration substrate and restraining means interconnecting the substrate to the integration substrate so that compressive forces are applied to the contact structures so that the contact structures remain in electrical contact with the contact pads.

61. An assembly as in Claim 60 wherein said restraining means is in the form of removable fastening means.

62. A semiconductor package assembly comprising a substrate formed of an insulating material having first and second surfaces and having conductive contact pads on the first and second surfaces, a plurality of semiconductor devices having contact pads facing the contact pads on the first and second surfaces of the substrate and resilient contact structures for electrically interconnecting the contact pads of the semiconductor devices and the contact pads carried by the substrate and for supporting the semiconductor devices in spaced-apart positions from the surfaces of the substrate so that the semiconductor devices lie in first and second parallel planes on opposite sides of the substrate and contact means carried by the substrate for making electrical contact to the semiconductor devices through the contact structures.

63. An assembly as in Claim 62 wherein said contact means is disposed in a plane and is disposed in a row.

64. A method for providing a structural contact for engagement with a contact pad carried by an electronic component by the use of a flexible elongate conductive element having first and second ends, securing the first end to the contact pad to form a first bond and forming a conductive material on the flexible elongate element to form a shell which extends over the flexible elongate element to provide the structural contact and which extends over first the bond and over the contact pad to adhere thereto so as to provide additional strength between the contact pad and the structural contact.

65. A method as in Claim 64 together with the step of forming a bend in the flexible elongate element between the first and second ends and forming the shell over the bend to provide yieldable spring-like properties for the contact structure.

66. A method as in Claim 65 together with the steps of providing an additional electronic component having a contact pad thereon together with the step of contacting the second end of the flexible elongate element to the contact pad on the additional electronic component to establish an electrical connection between the same.

67. A method as in Claim 66 together with the step of applying compressive forces between the electronic component and the additional electronic component so that compressive forces are maintained on the contact structures.

68. A method as in Claim 64 together with the step of securing the second end to the same contact pad to form a second bond.

69. A method for mounting a protuberant conductive contact to a conductive terminal on electronic component, the method comprising sequential steps of providing a wire having a continuous feed end intimately bonding the feed end to the terminal, forming from the bonded feed end a stem which protrudes from the terminal and has a first stem end thereat, bonding a second stem end into a sacrificial member mounted in spaced relationship from the component, severing the stem at the second stem end to define a skeleton, depositing a conductive material to envelop the skeleton and at least an adjacent surface of the component and eliminating the sacrificial member.

70. The method as in Claim 69 wherein during the eliminating step, the second stem end is severed from the sacrificial member.

71. The method as in Claim 69 wherein the conductive material is provided with a multitude of microprotrusions on its surface.

72. The method as in Claim 69 wherein the depositing step includes placement of a plurality of layers each differing from one another.

73. The method as in Claim 73 wherein at least one of the layers comprising conductive material has a jagged topography in order to reduce contact resistance of the protuberant conductive contact when mated to a matching terminal.

74. A method for mounting a protuberant conductive contact to a conductive terminal on an electronic component, the method comprising sequential steps of providing a wire having a continuous feed end to the terminal, intimately bonding the feed end to the terminal, forming from the feed end a stem which protrudes from the terminal and has a first stem end thereat, severing the stem at a second stem end to define a skeleton, depositing a conductive material to envelop the skeleton and adjacent surface of the terminal, performing the same steps on a plurality of terminals, at least one electronic component and wherein the terminals are in different planes, the forming steps resulting in a plurality of free standing protuberant stems, the severing steps being performed on the respective stems, all in a common plane.

75. A method as in Claim 74 wherein the terminals are in different planes and wherein the forming steps are carried out on the different planes.

76. A method for performing test and/or burn in procedures on a semiconductor device having a plurality of resilient contact structures mounted thereon by the use of a separate test or burn-in substrate having contact pads thereon arranged in a predetermined pattern, the method comprising positioning the semiconductor device with the plurality of resilient contact structures under compressive forces with respect to the test or burn-in substrate to yieldably urge the resilient contact structures associated with the semiconductor device into engagement and electrical contact with the contact pads of the test or burn-in substrate, performing tests on the semiconductor device while the resilient contact structures are in engagement with the contact pads of the test or burn-in substrate and removing the semiconductor device with the plurality of resilient contact structures from engagement with the contact pads of the

test or burn-in substrate after completion of the testing or burn-in.

77. A method as in Claim 76 for use with an integration substrate having a plurality of contact pads thereon arranged in a predetermined pattern, and following completion of the testing or burn-in procedures, performing the additional steps of placing the resilient contact structures of the semiconductor device into engagement with the contact pads on the integration substrate and forming a permanent connection between the contact structures and the contact pads of the integration substrate.

78. A method as in Claim 76 wherein said contact structures have base and free ends together with the step of changing the spacing between the free ends so that the spacing is different from the base ends and corresponds to the spacing of the contact pads on the substrate.

79. A method for mounting a protuberant conductive contact to a conductive terminal on an electronic component, the method comprising the steps of providing a wire having a continuous feed end, intimately bonding the feed end to the terminal, forming from the feed end a stem which protrudes from the terminal and has a first stem end thereat, severing the stem at a second stem end to define a skeleton, depositing a conductive material to envelop the skeleton and adjacent surface of the terminal.

80. A method as in Claim 79 wherein the forming steps and the severing steps are performed by a wire bonding apparatus and after the severing steps but before the depositing step shaping the skeleton by means of a tool external to the apparatus.

81. A method as in Claim 79 wherein the conductive material is provided with a multitude of microprotrusions on its surface.

82. A method as in Claim 79 with the depositing step including placement of a plurality of layers each differing from one another.

83. A method as in Claim 79 wherein the depositing step includes placement of a plurality of layers each different from one another.

84. A method as in Claim 79 performed on a plurality of the terminals and wherein the forming steps result in a plurality of

